

## Geocatalysis to Biocatalysis: How it all Began?

George D. Cody  
*Geophysical Laboratory*  
*Carnegie Institution of Washington*  
5251 Broad Branch Rd., NW, Washington, DC 20015  
USA  
[g.cody@gl.ciw.edu](mailto:g.cody@gl.ciw.edu)

Nabil Boctor  
*Geophysical Laboratory*  
*Carnegie Institution of Washington*  
USA

The organic & inorganic chemistry that lead to the emergence of life on Earth may have occurred within aqueous environments driven by the geochemistry associated with early planetary evolution. With the goal of understanding this chemistry, we have been studying the range of organic reactions that can be promoted in reduced carbon bearing fluids in the presence of transition metal sulfide catalysts. To date we find a broad range of reduction, addition, and oxidation reactions that require transition metal sulfides as either catalysts or reaction participants. Such reactions lead to the synthesis of organic compounds that bear similarity with familiar metabolic intermediates. The addition of nitrogen (in form of ammonia) and sulfur (in the form of H<sub>2</sub>S) broadens the range of reactions to include the synthesis of amino-acids, simple nitrogen heterocycles, and an array of sulfur containing species. These reactions are linked into a highly branched network. Superficially, the reaction pathways that lead towards prebiotic “anabolic” synthesis are reminiscent of the acetyl-CoA pathway utilized by both methanogenic and acetogenic microorganisms, rather than that of the reductive citrate cycle favored by some as the more likely choice for life’s first metabolic strategy. These results should not, however, be interpreted as pointing towards methanogens and acetogens as being particularly primitive in a hierarchical scheme for earliest life. Rather, these results more likely support the idea that if the natural world were functionally capable of synthesizing the essential building blocks for life, then the first organism(s) would have been a heterotroph(s).